Monitoring Completed Navigation Projects (MCNP) Program

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Funding Source
O&M

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Purpose of the MCNP Program

The Advancement of Coastal and Hydraulic Engineering Technology

To determine how well projects are accomplishing their purposes (how well they are resisting attacks by their physical environment)

(a) Create more accurate and economical engineering solutions
(b) Strengthen design criteria and methodology
(c) Improve construction practices and cost effectiveness
(d) Enhance Operation and Maintenance techniques

The MCNP program will identify where current technology is inadequate, (will determine where additional research is required)

Engineer Regulation ER 1110-2-8151

Engineering and Design

MONITORING COMPLETED NAVIGATION PROJECTS

31 July 1997

- **Deep- and Shallow-draft Navigation Projects located in the Coastal Zone, Estuaries, Rivers, Lakes, and Reservoirs**
- **Completed Navigation Projects Operated and Maintained by the Corps of Engineers**

Studies Completed in FY05

1. Pocket Wave Absorbers, Great Lakes (Pentwater, MI)

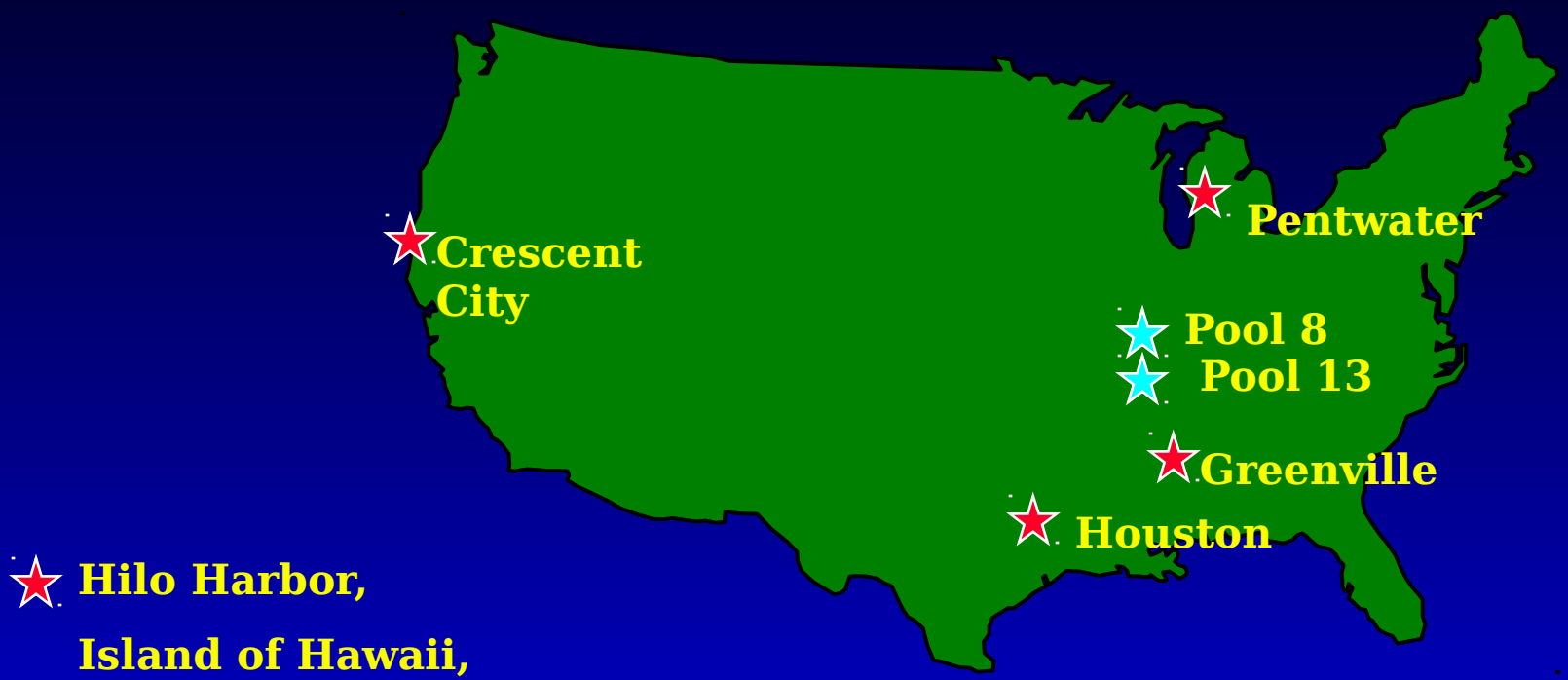
2. Houston Ship Channel, TX

3. Mississippi River Greenville Bridge Reach, Bendway Weirs

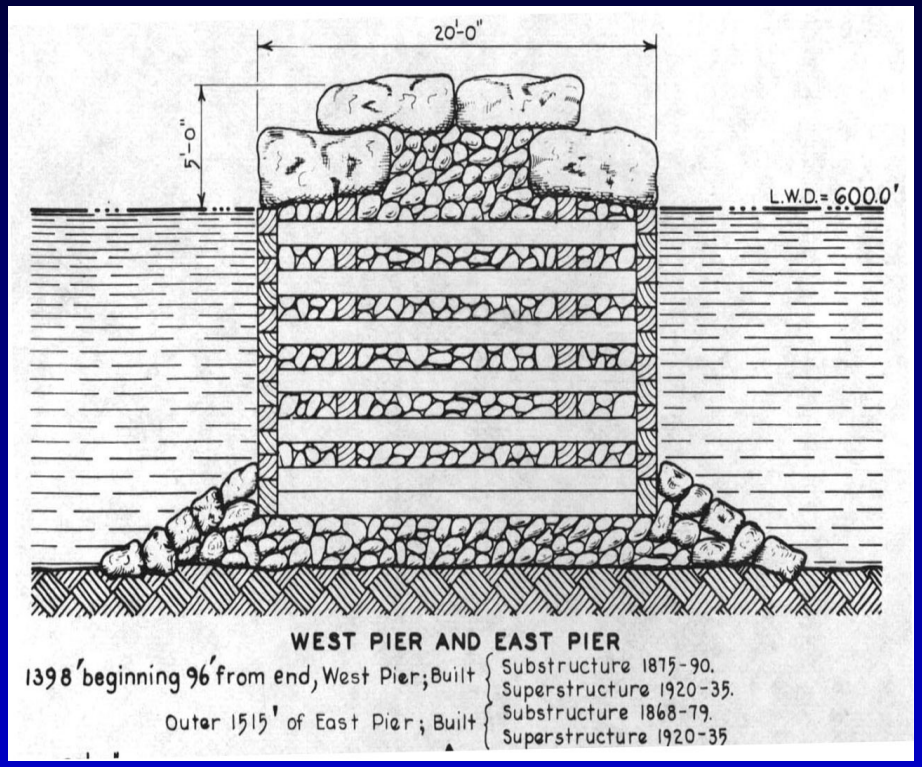
4. Upper Mississippi River Navigation Structures, Pools 8 and 13

5. Periodic Inspections (Crescent City, CA; and Hilo, HI)

MNCP Monitoring and Periodic Inspections Completed in FY05



Pocket Wave Absorbers, Great Lakes (Pentwater, MI)



Ed Thompson (PI), CHL
ERDC
James Selegean, LRE

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Pocket Wave Absorbers, Great Lakes (Pentwater, MI)

Pocket Wave Absorbers, Great Lakes (Pentwater, MI)

Pocket Wave Absorbers, Great Lakes (Pentwater, MI)

Conclusions

1. Study optimized dimensions of pocket wave absorbers.

2. Design guidance is based on dimensions and geometry of Pentwater harbor and channel (considered typically representative of Great Lakes), and on dominate spectral wave climate based on WIS data.

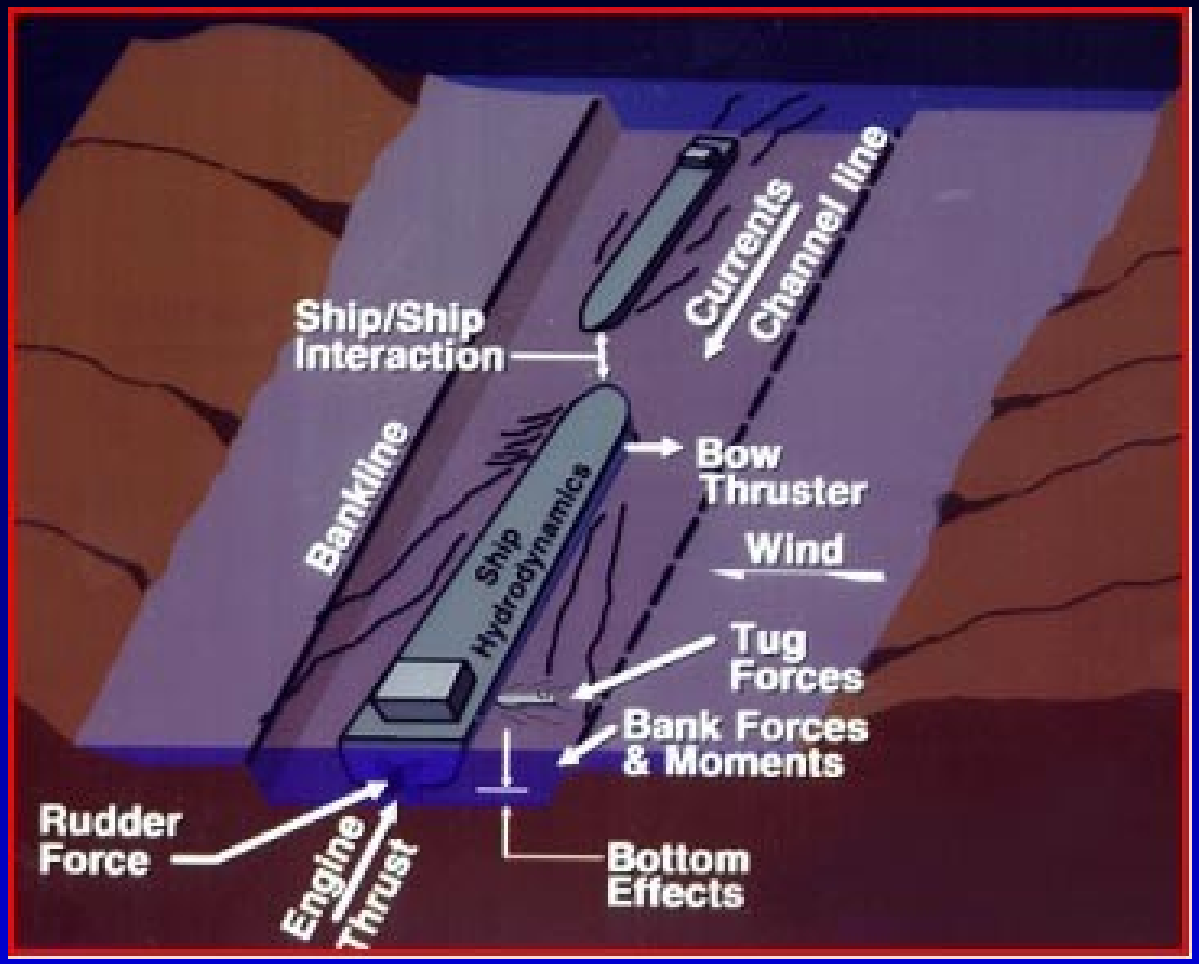
3. Channel width will affect wave absorber performance, and is quite variable even among the 7 harbors with absorbers presently installed.

4. Provided data for calibrating numerical model CGWAVE. This model will provide a useful tool in evaluating proposed pocket wave absorbers at other Great Lakes locations.

Houston Ship Channel, TX

Dennis Webb (PI), CHL, ERDC
Alton Meyer, SWG

Houston Ship Channel, TX



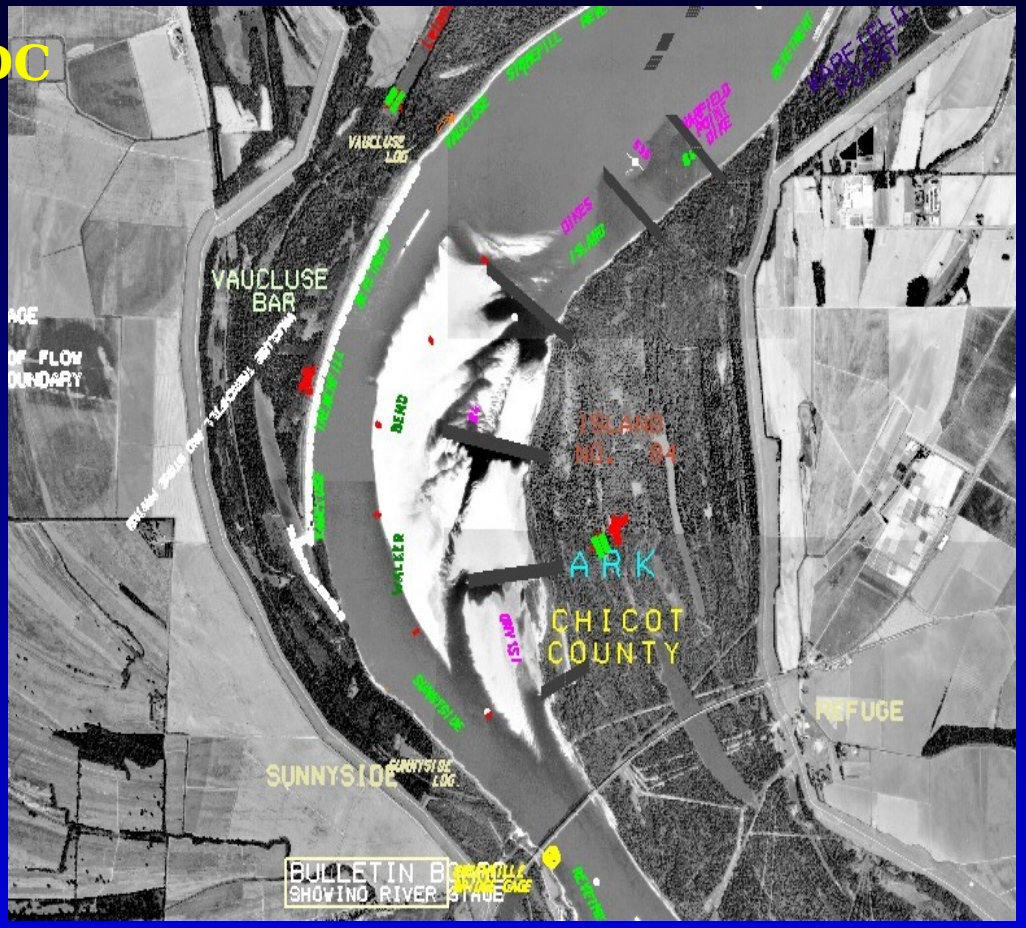
Houston Ship Channel, TX

1. Galveston Bay portion of Houston Ship Channel was increased from 40 ft x 400 ft to 45 ft x 530 ft, to accommodate larger tankers and containerships.
2. A second real-time ship simulator was installed and coupled with the existing simulator (to better understand ship-to-ship interactions during 2-way traffic). Ship pilots operated the coupled simulators for hands-on experience and recommendations.
3. Remote controlled ships were tracked in physical model by ship pilots.
4. DGPS were placed on tankers and containerships as they passed in the transition section to provide real-world data (centimeter accuracy).
5. Real-world data and 2-way simulator interaction runs provided an order-of-magnitude improvement to algorithms used in the simulators.

Mississippi River Greenville Bridge Reach, Bendway Weirs

Mike Winkler (PI), CHL, ERDC
Glenda Hill, MVK

Strong currents along west side of Mississippi River adversely affect downriver barge tows. Most-hit bridge pier in the U.S.



Mississippi River Greenville Bridge Reach, Bendway Weirs

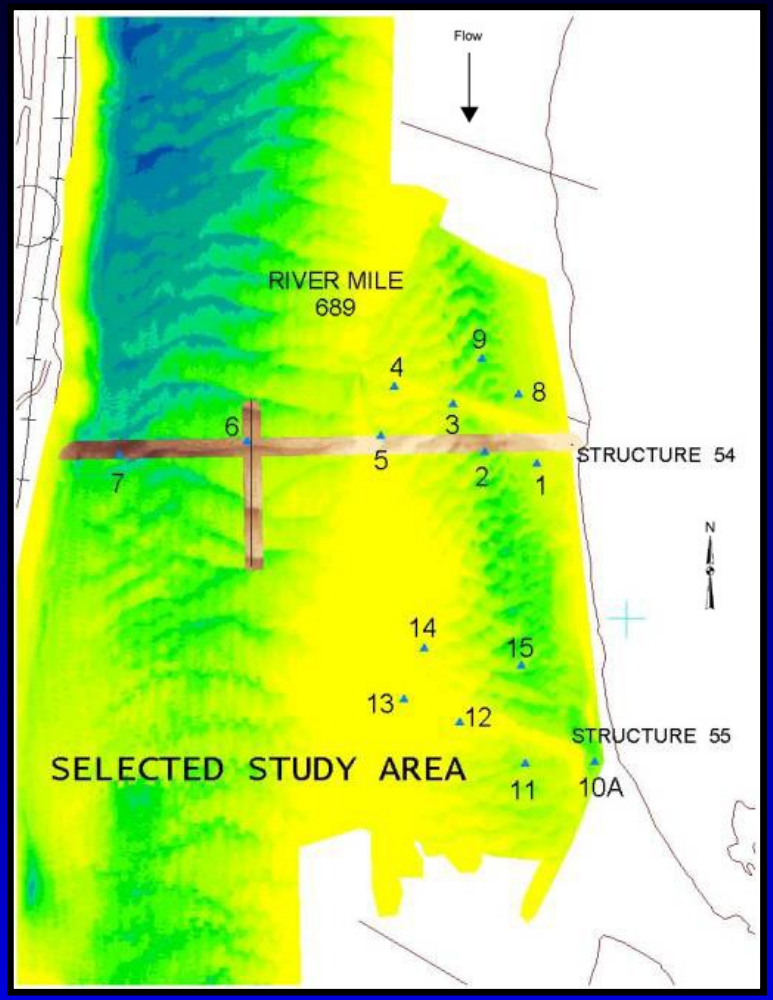
1. Greenville Reach affects barge tows passing bridge. Plan was developed to re-align Greenville Reach.
2. Physical model study indicated a stabilizing stone trenchfill inconjunction with 7 bendway weirs would be satisfactory.
3. Would force river channel thalweg further to the east, thus straightening the river approach to the bridge.
4. Time-lapse video systems were installed on bridge to monitor traffic. Floats draft 8-ft were tracked to obtain current velocities and directions. ADCP was used to measure river discharge and navigation hydrodynamic conditions. Bathymetric data were obtained with multi-beam systems.
5. Channel re-alignment and currents were similar to physical model results. Developed channel bathymetry was effectively reproduced in the river.

Upper Mississippi River Navigation Structures, Pools 8 and 13

David Abraham (PI), CHL ERDC
Jon Hendrickson, MVP
Kevin Landwehr, MVR

Need to quantify bed load transport in rivers is universal. Mechanical and analytical methods (while accurate in the laboratory) are only moderately successful in the real world.

A new methodology called Integrated Surface Section Difference Over Time (ISSDOT) was developed using multi-beam bathymetric survey data.



Upper Mississippi River Navigation Structures,

ISSDOT Conclusions

1. Physically impossible to actually measure total bed-load transport in rivers. Hence, ISSDOT results from Pool 8 were compared to mechanical samplings from the Nile (because sediment and hydraulic characteristics are similar), and from 3 analytical transport functions; (a) Einstein, (b) Toffaleti, and (c) van Rijn.

2. ISSDOT predicted 164 tons/day. ISSDOT slightly under-predicted the other methods.

3. The ISSDOT under-prediction is related to the time-step interval between successive bathymetric measurements. Future surveys should be at shorter and more regular time steps.

4. Large-scale proof-of-concept laboratory studies should be conducted.

Upper Mississippi River Navigation Structures, Pool 8 Wing Dams

US Army Corps of Engineers

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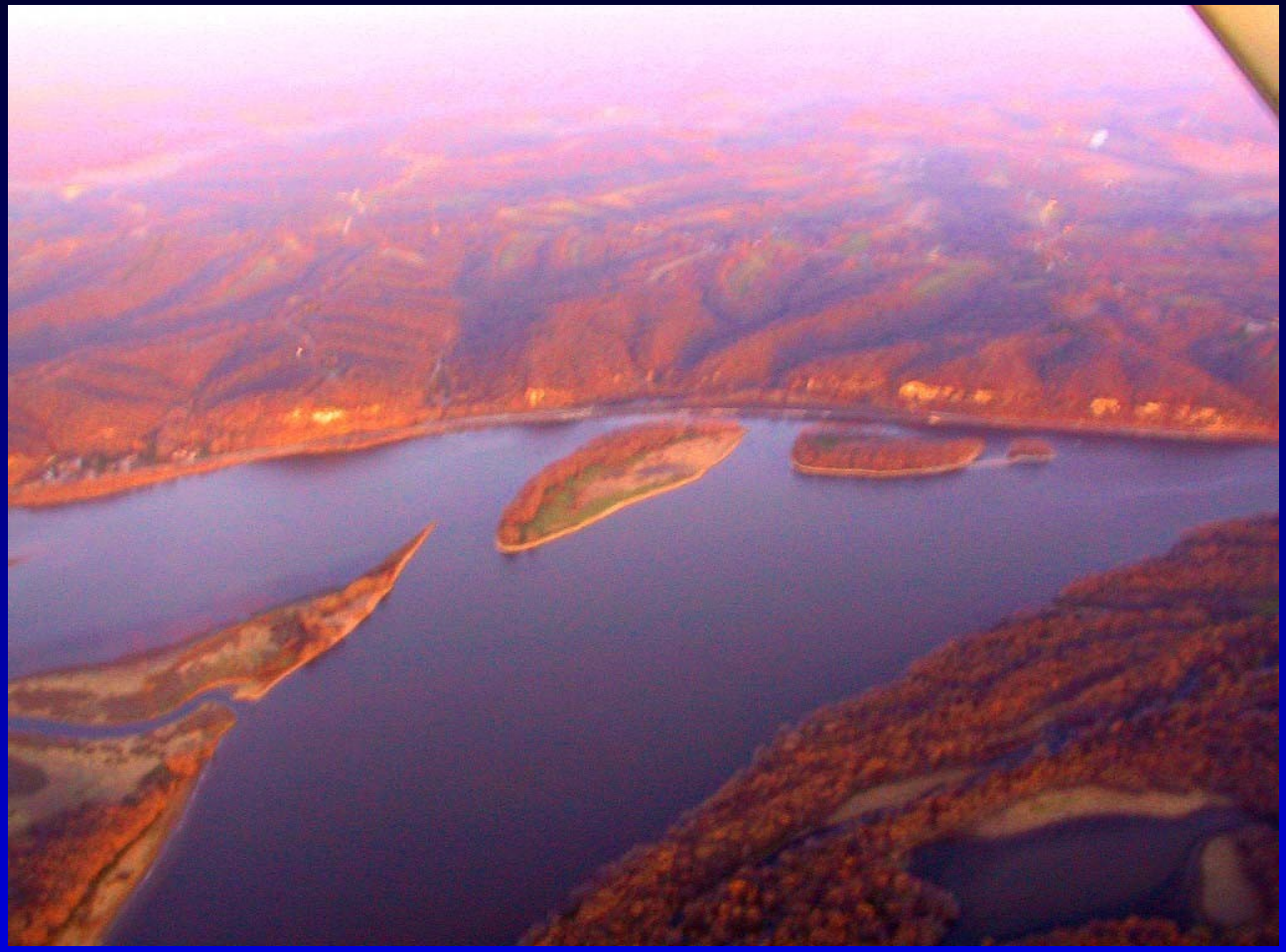
Upper Mississippi River Navigation Structures, Pool 8 Wing Dams Conclusions

1. Pool drawdown (1.5 ft) during Summers of 2001 and 2002 to expose mud flats, promote seed germination, and benefit fish and wildlife.
2. Wing Dam submergence and floodplain conveyance decreased.
3. Flow patterns around structures was altered.
4. Resulted in sediment mobilization and scour of the navigation channel.
5. ISSDOT results were compared to (a) District Sediment Budget, and (b) analytical functions.
6. ISSDOT and analytical functions yielded 800 tons/day. Sediment Budget yielded 550 tons/day (uncertainty exists about suspended load).
7. River managers can more effectively plan their dredging with ISSDOT.

Upper Mississippi River Navigation Structures, Pool 13 Closure Dams



Upper Mississippi River Navigation Structures, Pool 13 Closure Dams Conclusions

1. 3 Closure Dams were constructed during Spring 2001 (submerged weirs to allow flow into backwater areas but at reduced rate), thus increasing flow in Main Channel.
2. Need to determine by ISSDOT if channel dredging would be reduced, and whether backwaters would fill with sediment.
3. For Main Channel, all regions had same scour first then redeposition trend. Lower region redeposition was not as much as other regions, thus showed a slight scour measurable difference (few tenths of a ft) between November 2001 and July 2004. Redeposition here may resume in future years. Dredging may not be reduced.
4. For Backwaters, all measurements show a net deposition trend, up to about 1.0 ft, for this study period.

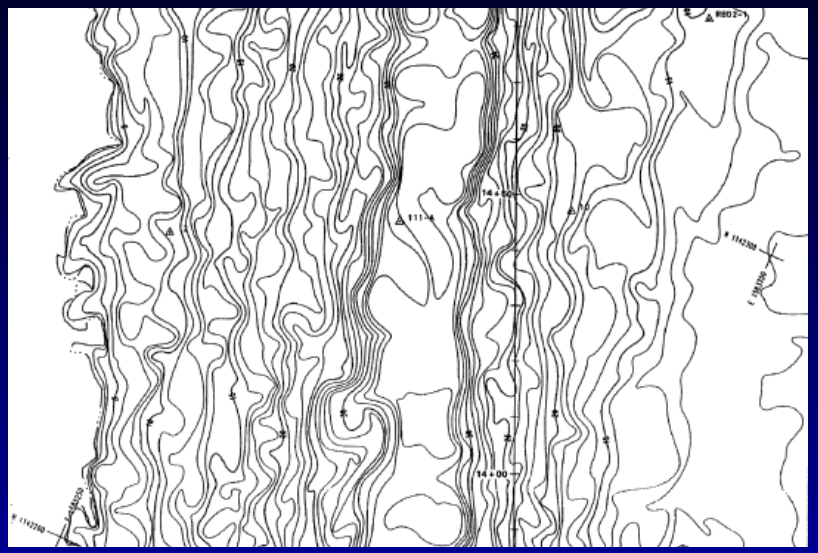
Periodic Inspections

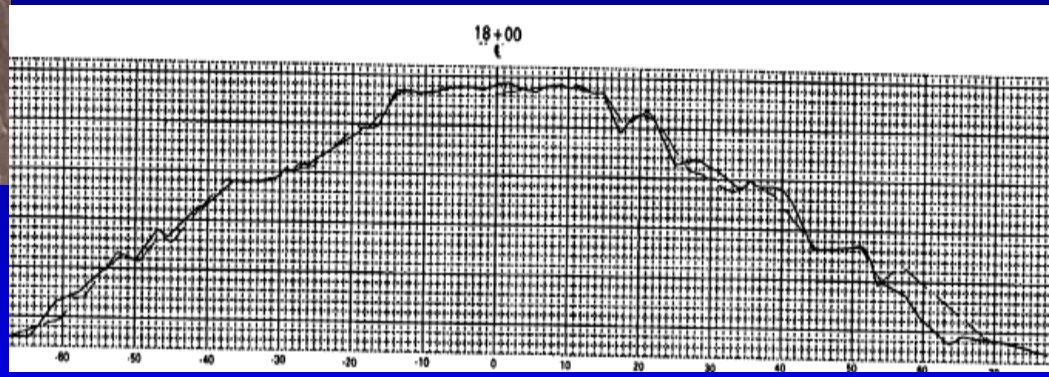
- PI: Jeff Melby
- Problem
  - Lack of long-term structure performance data
  - Lack of documented long-term experience
- Products
  - TR - Crescent City Breakwater survey
  - Draft TR – survey of Hilo, Nawiliwili, Kahului, Laupahoehoe Breakwaters
  - eCoastal server for MCNP data
- Benefits
  - Better performance knowledge translates to better designs

Periodic Inspections

- Coastal Structures
- Work closely with Districts
- Detailed relatively low-cost monitoring (lidar, photogrammetry, walking surveys, concrete cores, photographs)
- Measure stone and concrete armor movement, breakage, subsidence, etc.
- NEW – Correlate performance with forcing
- NEW – place data into eCoastal GIS

Periodic Inspections





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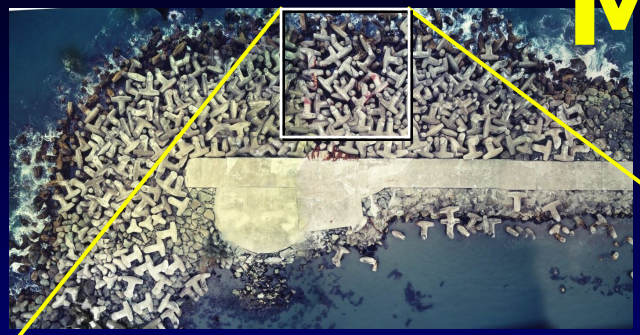
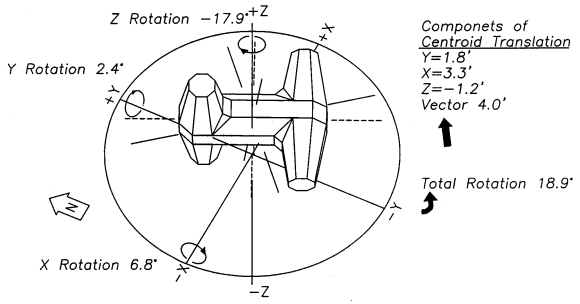
Crescent City Dolos Movement



Cumulative Movements
by Aerial Survey

Dolos A

27 Jul 04



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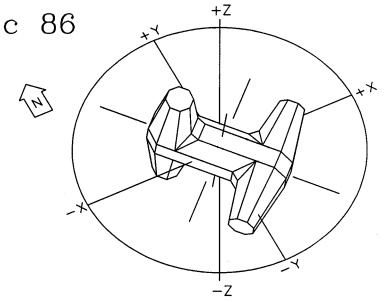


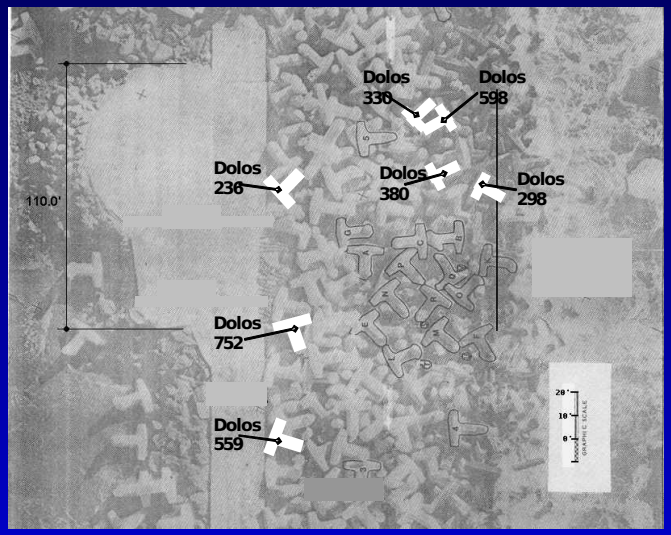
All movement values given are with respect to the State Plane Coordinate system. To emphasize rotation the new (rotated) orientation of the dolos local coordinate system is shown with solid axes; the previous orientation is shown with dashed axes.

Note, as viewed the X & Y axis rotation directions may appear reversed when the dolos is oriented more than 90° (about the Z axis) from the reference dolos orientation.

Dolos Strength and Breakage

Dolos Strengths

Date Cast	Comp Strength	Tensile Strength
1974	7700 psi	1300 psi
1986	9400 psi	1600 psi



42 ton fiber reinforced dolosse

No recent movement to note

50 total broken

- **14/760 cast in 1986**
- **36/246 cast in 1974**
- **No new breaks since 1993**

Hilo, Hawaii
Lidar Terrestrial and Multi-beam Sonar Bathymetry Surveys

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Improved Survey Records

Microsoft Excel - Kahului

File Edit View Insert Format Tools Data Window Help Adobe PDF

Arial 10 B I U

Reply with Changes... End Review...

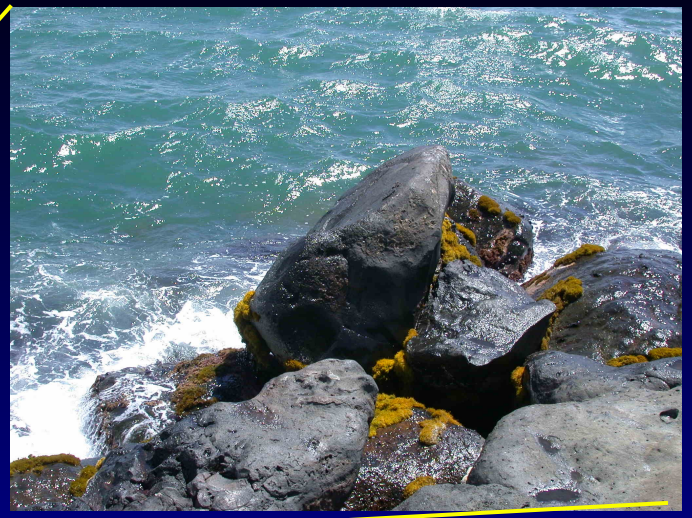
A21 22+40

	A	B	C	D
21	22+40	N136	Transition of repair zones; crest elevation drop; monitor sideslope settling	
22	23+20	N135	OS, slight settling	
23	23+20-24+67	N134	Settling; flipped armor stone at 24+50	
24	26+26	N131	Begin ribcap; extension of Pier 1 Harborside of breakwater	
25	26+26	N130	New dolphin and walkway adjacent to breakwater; built 2005	
26	26+26	N129	HS, Eroded sideslope	
27	26+70	N128	Rib 8, OS, Break #1, Dolos w/ Fluke tip break (old Station 25+00)	
28	26+92	N127	Rib 12, OS, Break #2, Dolos w/ straight shank-fluke break	

Sheet1 Sheet2 Sheet3

Draw AutoShapes

Ready NUM



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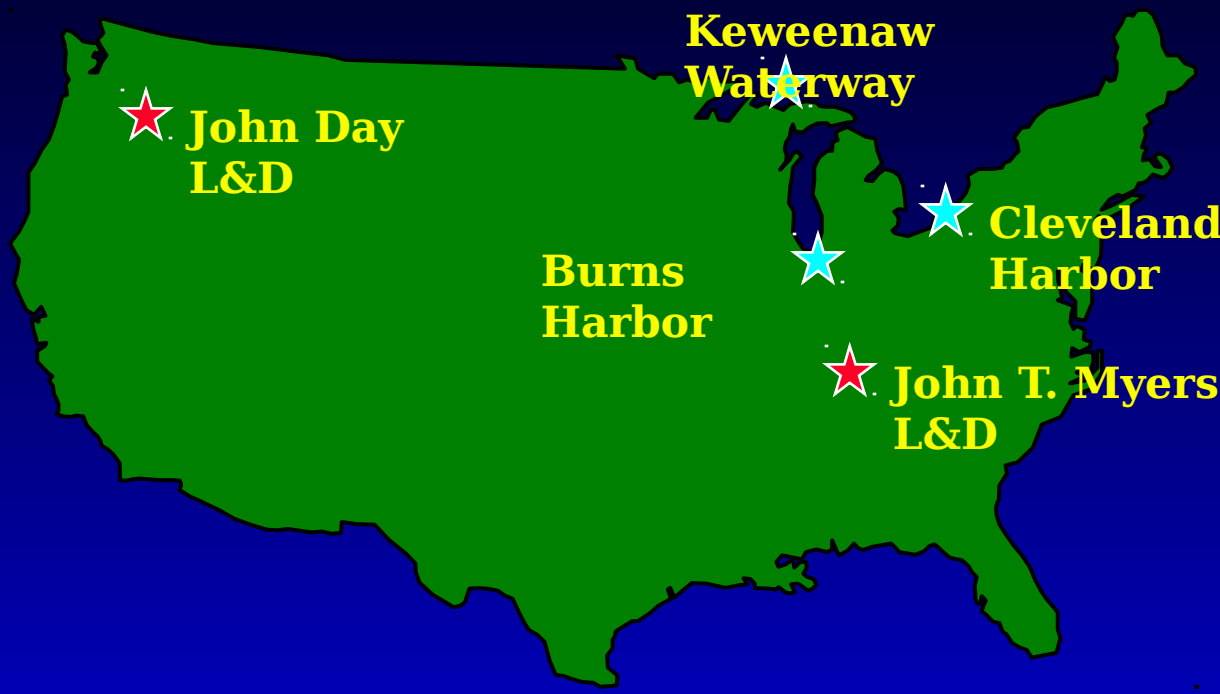
FY06 MCNP Program

1. John Day Lock and Dam, Hazardous Current Conditions
2. Kaumalapau Harbor, CORE-Loc Breakwater Armor
3. Great Lakes Breakwater Armor, Stone Testing Protocols
4. Periodic Inspections; Burns, Cleveland, and Keweenaw Waterway
5. John T. Myers Locks and Dam, Lock Wall Armor Deterioration

MNCP Monitoring and Periodic Inspections FY06



Kaumalapau Harbor,

Island of Lanai, HI

US Army Corps of Engineers

Coastal and Hydraulics Laboratory - ERDC

John Day Lock and Dam

Product Delivery Team

Randy McCollum (PI) and Thad Pratt, CHL, ERDC
Kyle McCune and Sean Askelson, NWP

Problem

Addition of (a) Spillway Flow Deflectors, and (b) Spill Pattern Generators, and (c) Changed Operations to improve fish passage through the tailrace environment and water quality, have adversely impacted the Dam's ability to safely meet it's navigation mission under certain river conditions.

Columbia River Towing Association (CRTA) has reported several instances of unsafe navigation conditions. Navigation conditions have been negatively impacted due to these modifications. System modifications should be investigated to eliminate unsafe navigation situation existing here and at 7 other similar dams located on the Lower Columbia and Lower Snake Rivers.

Location Map, John Day Lock and Dam

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John Day Lock and Dam, Columbia River

Study Approach

1. Physical model predicts a significant flow moving from the spillway toward the powerhouse, opposite in direction from that measured by a limited 2003 ADCP survey. This reverse entrainment in the model is believed to be directly related to underestimating the current velocities in the vicinity of the navigation lock approach.
2. Comprehensive data set under various flow conditions will be acquired to understand impact of flow deflectors and spillway operations on the trailrace environment adjacent to the navigation lock. Entails intense monitoring of the entrainment between spillway, flow deflectors, and powerhouse.
3. Changed river bottom topography will be acquired to determine impacts on currents.
4. Monitoring will establish impact of fish passage changes, and create a data set for improvements to both physical and numerical modeling.

John Day Lock and Dam

John Day Lock and Dam

John Day Lock and Dam

John Day Lock and Dam

John Day Lock and Dam

US Army Corps of Engineers

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John Day Lock and Dam

US Army Corps of Engineers

Coastal and Hydraulics Laboratory - ERDC

John Day Lock and Dam

1. 2-D ADCP side-looking meters will be installed (a) on face of powerhouse, (b) along the length of the skeleton bays, (c) near downstream end of guard wall, and (d) along north bank approximately 1,000 ft downstream of the end of the guard wall. Equipment purchased for installation Spring FY06.
2. Positions were selected to monitor entrained flow from powerhouse tailrace into the spillway, high velocity flow along end of guard wall, and velocities on barge tows along north bank where industry reports problems.
3. Video monitoring will record navigation approach, and time synchronizing all recording devices to determine when hazardous conditions occur.
4. Discharges will be determined by taking multiple transits over specific cross sections using 3-D ADCP probe mounted on survey boat.
5. Special operations of the dam will be arranged to examine how dam operation impacts conditions in the

Kaumalapau Harbor Breakwater
Island of Lanai, Hawaii

Product Delivery Team

Steve Hughes (PI) and Jeff Melby, CHL, ERDC; Ed O'Neil, GSL, ERDC

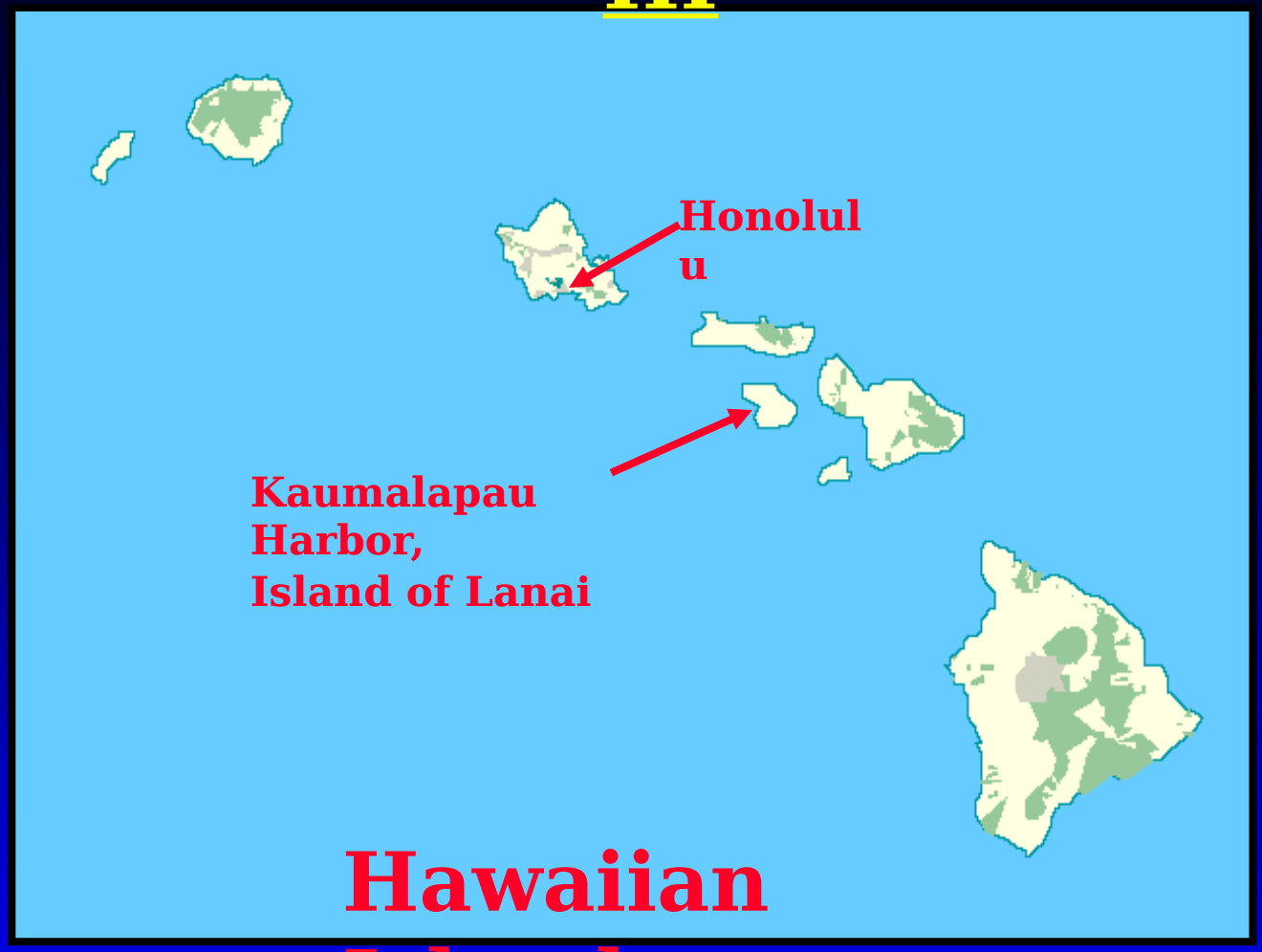
Tom Smith and Jessica Hays, POH

Problem

Harbor, constructed in 1922, is the only deepwater port on the island, and services the hotel tourist and farming industry, and import of food and commercial goods. The breakwater has severely deteriorated over the years.

Because of non-availability of large quarry stone, it is necessary to use manufactured armor units at this site (water depths 70 ft; wave heights 30 ft). 35-ton CORE-Loc armor units (largest ever manufactured) will be installed (790 units). Will be placed over existing broken dolos armor units. It is significantly important to understand the design, stability, construction, and performance of these units.

Location Map, Kaumalapau Harbor, HI



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Kaumalapau Harbor Breakwater

Kaumalapau Harbor Breakwater

US Army Corps of Engineers

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Kaumalapau Harbor Breakwater

Kaumalapau Harbor Offloading

Old Shape 35-Ton CORE-Loc,

35-Ton CORE-Loc for Rehabilitating Kaumalapau Harbor Breakwater

790 CORE-Loc units will be cast

Study Approach

This breakwater repair provides a unique opportunity to monitor a project that incorporates the largest CORE-Loc armor units ever utilized by USACE.

Objectives include detailed documentation and assessment of breakwater repair activities (underlayer preparation, armor unit fabrication, placement, etc.) for base-line data, and subsequent monitoring and evaluation of project performance. Monitoring and quality control of the underlayer shaping will be essential to the overall success of the CORE-Loc placement.

Specific CORE-Loc units will be marked, photographed, and their location surveyed by GPS. Weathering and weak zone within units will be tracked. The MCNP program will leverage resources with the District's Project Inspection Program. Sub-aerial precision armor unit monitoring will be conducted annually, and following significant storm events.

FY05 Construction Delays

1. Contractor fabricated 10 forms based on previous Azores configuration.
2. Storm damage in Azores resulted in a few cracks in some CORE-Locs.
3. CORE-Loc redesign was recommended.
4. 3 new CORE-Loc test forms were fabricated.
5. Difficulty with concrete mix design not meeting both temperature and temperature differential specifications.
6. Further analysis indicated Azores problems may have been with placement.
7. Hence, previous Azores form configuration could possibly have been o.k.
8. Bottom Line: Prototype units will be formed in 2006 instead of 2005.

Monitoring Program

1. In-Situ Wave Measurements
2. Wave Hindcast and Transformation
3. Breakwater Settlement Measurements
4. Armor Unit Movement Measurements
5. Toe Stability Monitoring
6. CORE-Loc Concrete Strength
7. Breakwater Inspections
8. eCoastal GIS for Coastal Structures deployment
9. Reporting

Great Lakes Breakwater Armor, Stone Testing Protocols

Product Delivery Team

Danny Harrelson (PI), GSL, ERDC

Joe Kissane, LRC; Michael Allis, LRE; John Kolber, LRB

Ron Erickson, Consultant (formerly LRE District Geologist)

Problem

Specifications for armor stone for breakwaters and jetties include objective criteria from laboratory tests, and subjective criteria based on quarries and stockpiles. Issues relate to stone durability. Variability of quality between and within quarries are exceedingly problematic.

ASTM tests presently used were designed for small concrete aggregate and stone many orders of magnitude smaller than stone on breakwaters. These small-scale tests are not appropriate for stone weighing tens of tons.

Keweenaw Waterway, MI

West Jetty

East Jetty

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Burns Harbor, IN

Cut Limestone

Blasted Dolomite

Cleveland Harbor, OH

Cut Sandstone

Blasted Limestone

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Wire-Saw Cut Quarry Operation
Reed Quarry, Bloomington, IN

Drilled and Blasted Quarry Operation
Valders Quarry, Valders, WI

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Drilled and Blasted Quarry Operation
Dempsey Quarry, Waterloo, WI

High-Energy Blasted Dolomite
McCook Quarry, McCook, IL

Study Approach

Objectives are to investigate and evaluate effects of scaling on lab test results using samples of various rock types used in Great Lakes coastal projects. Several different sizes of each different stone type from different quarries will be cut to the same relative dimensions. Some of these samples will be tested prior to any weathering exposure using existing protocols. Scaling effects will be ascertained.

Various size samples will be placed on prototype structures to experience weathering effects of wet/dry and freeze/thaw, and large wave attack. Results will be compared to prior lab tests.

Results will be used to develop guidance and new protocols for armor stone selection with respect to ranking of stone types, excavation methods, and geologic characteristics of material available in a region.

Quarry operators indicate test stone is available at minimal or no cost, including dolomite, limestone, granite, sandstone, and quartzite.

FY06 Research Efforts

Prototype Stones to be Placed on Structures

1. Develop quarry supply arrangement for procuring Index Stones to place on structures.
2. Index Stones should be representative of materials used in the projects.
3. Samples should be obtained by means consistent with project histories (cut or blasted). Blasted stones will be cut to shape after blasting, to retain all impacts of excavation method.
4. 3 scales (sizes) of stones should be evaluated: (a) Conventional lab test size; (b) larger scale lab tests; and (c) Small prototype size structure stone (3 to 8 tons).
5. Stones will be cut by water saw (no saw blades).

FY06 Research Efforts

Prototype Stones to be Placed on Structures

6. Stone placement will be coordinated with O&M activities of Division Office.
7. 3 kinds of Index Stones: (a) cube, 1:1:1 aspect ratio; (b) rectangular, 1:1:2.5 aspect ratio; and (c) conventionally excavated with about the same mass as (a) and (b) above; hence, 4 types of Index Stones
8. Obtain stones from 12 different quarries; thus, 12 quarries x 4 types of Index Stones = 48 small prototype stones placed on the 3 structures per repetition. Number of repetitions to be determined (based on budget constraints).
9. Stones from the different quarries and the different rock types can be compared objectively.

FY06 Research Efforts

Laboratory Tests

1. 3 sizes of slab sawed laboratory samples: (a) conventional (500 gm); (b) larger (5,000 gm); and largest (50,000 gm). Hence, 3 sizes per quarry.
2. 12 quarries x 3 sizes per quarry x 5 repetitions = 180 lab samples.
3. Laboratory test results will be correlated with field observations corresponding to that particular stone type.
4. Guidance documents should be up-dated for construction representatives and geotechnical engineers who prepare design specifications.
5. Enhanced ASTM test criteria protocols for armor stone will be deduced. Guidance documents will be prepared for armor stone use around the Great Lakes. Present documents are evolving, and need to be standardized. Update quarry ETL for mapping and geological observations.

Periodic Inspections FY06

1. Keweenaw Waterway west breakwater, MI
2. Burns Harbor breakwater, IN

   Previous monitoring 1985-1992

   Previous periodic inspections, 1995 and 1999
3. Cleveland Harbor east breakwater, OH

   Previous monitoring, 1980-1985

   Previous periodic inspection, 1995

Wall Armor System
John T. Myers Locks and Dam, Ohio River

Product Delivery Team

Stan Woodson (PI), GSL, ERDC

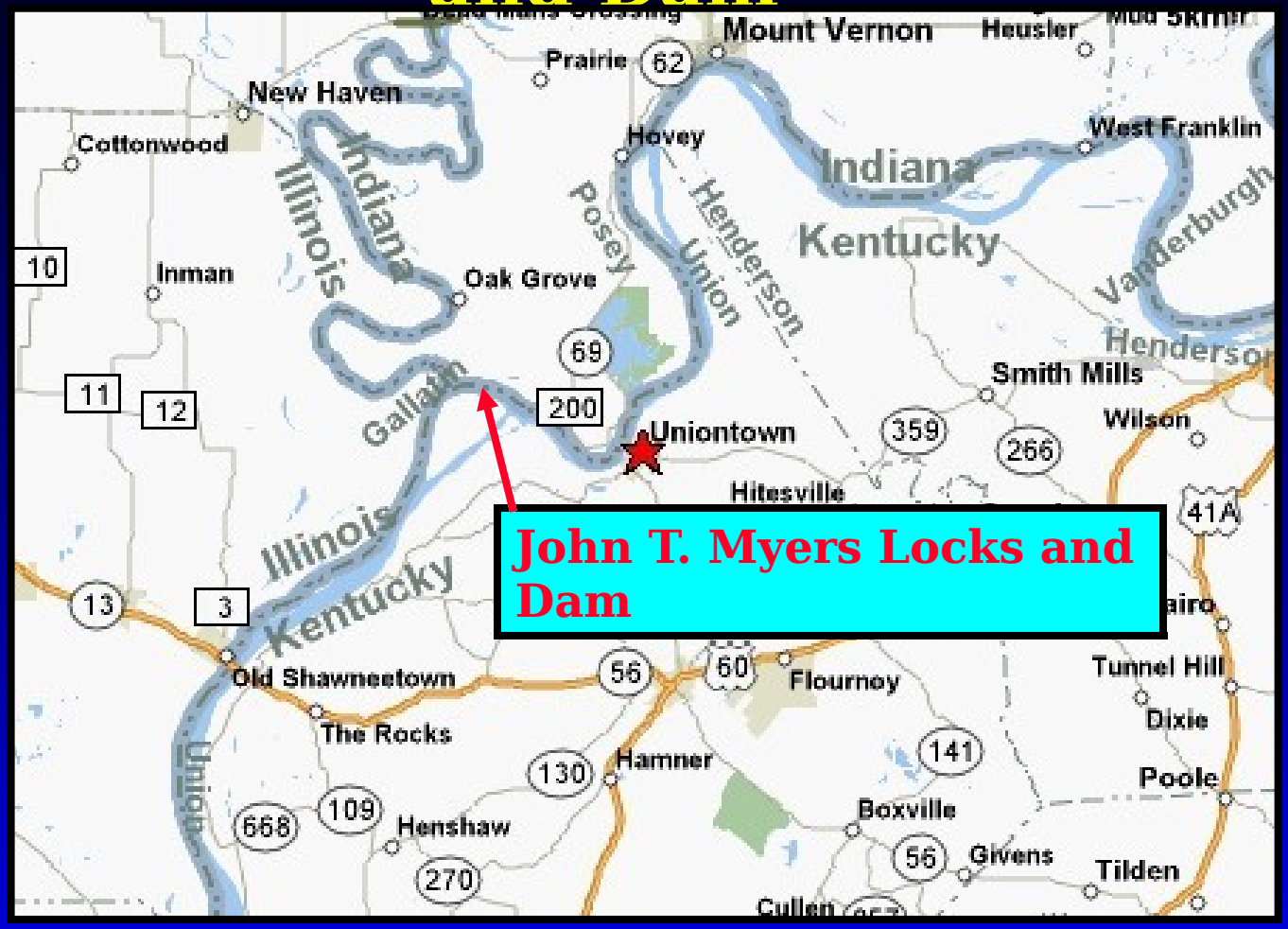
Rick Lewis, LRL; Jeff Stamper, MVS; Mike Tarpey, MVR

Problem

Lock wall armor systems are experiencing large amount of damage due to large number of vessels passing through the locks. Majority of damage includes gouges and spalls in the concrete adjacent to armor strips. Many of the gouges are next to vertical joints. Several locations includes broken armor.

Majority of damage occurs in 1,200-ft lock, due to impact and abrasion by commercial barge traffic that typically use this lock. Broken wall armor is vulnerable to "catching" protruding metal on barges (a special concern for barges that have protection themselves). When armor is worn flat, it is no longer effecting in protecting the surrounding concrete.

Location Map, John T. Myers Locks and Dam



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John T. Myers Locks and Dam, Ohio River

US Army Corps of Engineers

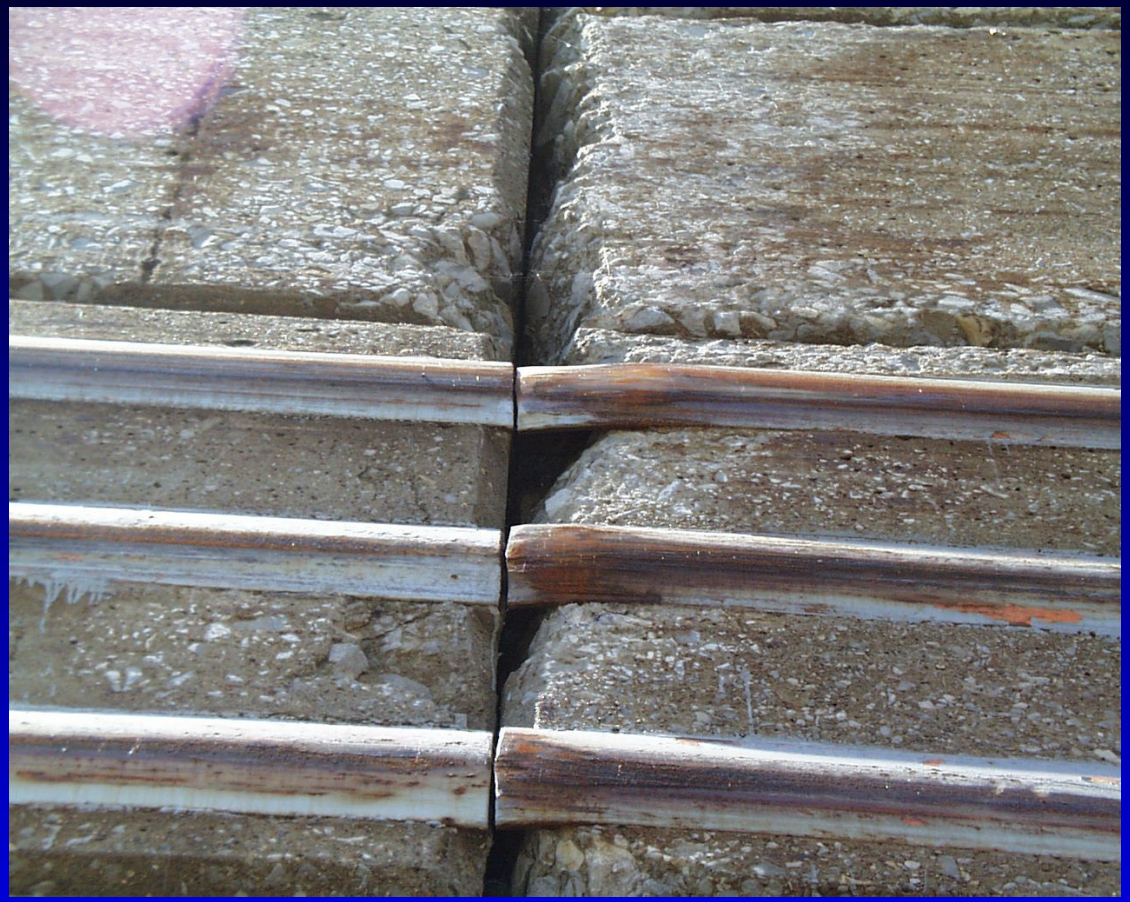
Coastal and Hydraulics Laboratory - ERDC

Wall Armor System Deterioration

Wall Armor System Deterioration

Wall Armor System Deterioration

Wall Armor System Deterioration



Wall Armor System Deterioration

Wall Armor System Deterioration

Wall Armor System Deterioration

Study Approach

The design parameters for this lock were insufficient, resulting in extensive wear of the lock walls. Design did not provide for wall armor protection at the concrete joints, with considerable damage to the concrete and armor. Performance prediction technology was not fully utilized.

The ability of this lock to remain fully functional is significant to insure continued efficient operation of the system, a major artery for commercial navigation in the U.S. Innovative repair techniques must be applied to not disrupt navigation traffic through the locks and on the Ohio River.

Continuous monitoring should be undertaken to provide prediction indicators of the rate and extent of projected deterioration of the wall armor system. This will provide an indication of the amount of time available for development of non-disruptive repair methodology.

Wall Armor System FY05

1. Problem is extensive along Upper Mississippi locks, as well as Ohio River.
2. St. Louis and Rock Island Districts have provided exceedingly helpful discussion about Locks 18, 19, 20, 21, 22, 24 and 25, as well as at Lagrange on the Illinois River.
3. These lock wall designs have not previously provided for vertical concrete joint protection (design parameters were insufficient).
4. Extensive repairs are necessary at John T. Myers, as well as other locks.
5. Innovative repair techniques that will not disrupt navigation traffic are presently being researched.
6. Baseline conditions for John T. Myers have been established. Extensive survey and documentation of existing visual damages have been made.

Wall Armor System FY06

1. Conduct thorough evaluation of FY05 Damage Survey Data for John T. Myers and Markland Locks.
2. Inspection of isolated damage zones at additional locks to document range and extent of wall armor damage.
3. Perform annual damage survey of John T. Myers to monitor changes from baseline conditions.
4. Assess use of state-of-the-art nondestructive test techniques to evaluate extent of concrete damage and concrete quality at damaged sections.
5. Apply innovative concrete repair techniques to selected damaged concrete sections for future monitoring.
6. Repairs must be performed with little or no effect on continued operation of the locks.

FY06 MCNP Program

1. John Day Lock and Dam, Hazardous Current Conditions
2. Kaumalapau Harbor, CORE-Loc Breakwater Armor
3. Great Lakes Breakwater Armor, Stone Testing Protocols
4. Periodic Inspections; Burns, Cleveland, and Keweenaw Waterway
5. John T. Myers Locks and Dam, Lock Wall Armor Deterioration
6. Great Lakes Pocket Wave Absorbers, Pentwater, MI
7. eCoastal GIS for Coastal Structures
8. Technology Transfer
9. Program Management

eCoastal GIS for Coastal Structures

Need for this Database

1. Data have been collected for about 20 years by MCNP (formerly MCCP), the majority being coastal and functional performance.
2. Coastal performance data continue to be acquired both by MCNP and other Corps research programs at an exceedingly rapid rate.
3. Data from these disparate efforts are not stored in a common database, or in a common format.
4. These data are not readily accessible once the project is complete.
5. A common database and interface would facilitate long-term Corp-wide access to these data.
6. It is estimated over 50 percent of Corps personnel will retire in the next 10 years. This corporate knowledge should be preserved.

Homepage - MCNP Web Site

Monitoring Completed Navigation Projects Program

MCNP

US Army Corps of Engineers | Engineer Research & Development Center | Coastal & Hydraulics Laboratory

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Program Description

The Monitoring Completed Navigation Projects (MCNP) program evaluates the performance of completed civil works navigation projects. Its objective is to obtain information for verifying or improving navigation project performance. Monitoring is conducted to (1) determine if the project is functioning as designed, (2) improve design procedures, (3) improve construction methods, and (4) improve operations and maintenance techniques.

For complete description in Adobe PDF format click here.

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